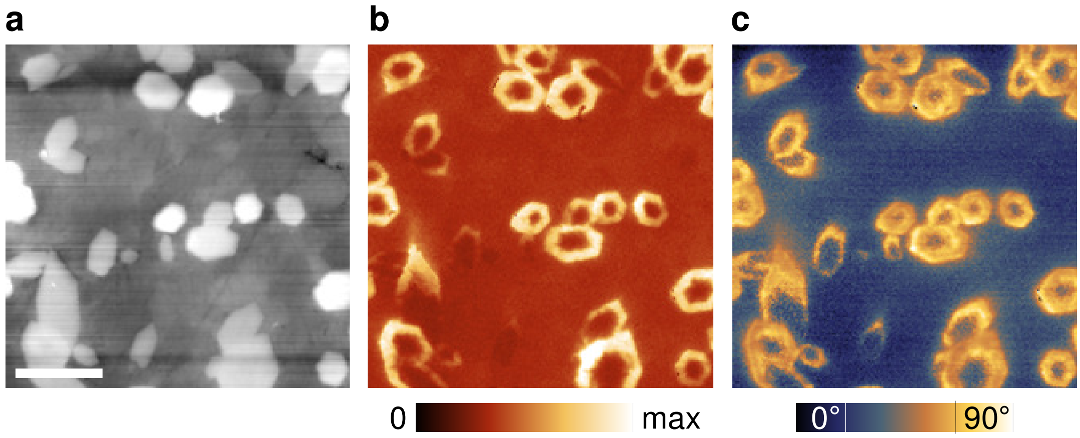

Supplementary Figure S1. IR s-SNOM images of mechanically polished sample without polishing residues. (a) Topography, (b) IR amplitude and (c) IR phase image. The topography is smooth on the nanowires and does not show any polishing residues. The near-field images show the typical ring-like contrast as seen in Fig. 1bc in the main text. We thus can exclude that the polishing remainders are the cause of the ring-like infrared contrast. The scale bar denotes 1 μm. Note that this sample is not included in Fig. 1 as it was grown within another experiment, although using the same growth conditions.

Supplementary Methods

Discussion of the possible influence of polishing on the infrared near-field contrast

The preparation of a cross-section creates an artificial surface and the properties of this surface might be different from bulk properties, particularly in semiconductors due to carrier depletion for example. Such depletion layers are typically in the range of a few nanometers.[61] For a surface sensitive technique such as scanning tunneling microscopy (STM), this might be indeed an issue, as STM is very dependent on the electronic state of the surface. s-SNOM, however, is quite different in this regard. s-SNOM probes a volume near the surface (and thus a substantial amount of interior material) rather than just the surface. The probing depth is typically around 30 nm.[62,63] A depletion layer of a few nanometer thickness will thus not significantly modify the s-SNOM signal.

Another aspect of the sample preparation is that polishing and ion-beam milling will create crystal damage and eventually a thin amorphous surface layer. Yet both procedures will yield a different amount and type of damage, which might affect the depletion layer and image contrast. By comparing mechanically and FIB polished cross sections, we do not see a significant difference in the s-SNOM contrast. In both cases we observe a bright ring in the as-deposited nanowires, which vanishes after annealing. This is another clear indication that the damaged/depleted surface layer has only minor influence on the image contrast.

In summary: As a volume rather than the surface states are probed, and because the s-SNOM signal is independent of the polishing procedure, we can conclude that the effect of surface polishing is minor regarding the qualitative image contrast. The exact values obtained for the local carrier density on the other hand might be modified due to the surface polishing.

We furthermore emphasize:

The contrast ring vanishes after annealing, but both as-deposited and annealed nanowires were polished the same way. Within one image of the as-deposited nanowires (*e.g.* Fig. 1a), the contrast ring varies for the individual nanowires (some as-deposited nanowires even do not even exhibit a contrast ring), although the polishing is exactly the same for the nanowires seen in one image. Obviously we observe an intrinsic nanowire property in the near-field images.

Supplementary References:

61 Mora-Seró *et al.* Determination of carrier density of ZnO nanowires by electrochemical techniques *Appl. Phys Lett.* **89**, 203117 (2006).

62 Taubner, T., Keilmann, F. & Hillenbrand, R. Nanoscale-resolved subsurface imaging by scattering-type near-field optical microscopy *Opt. Express* **13**, 8893-8899, (2005).

63 Krutokhvostov *et al.* Enhanced resolution in subsurface near-field optical microscopy *Opt. Express* **20**, 593 - 600, (2012).